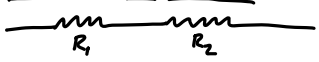
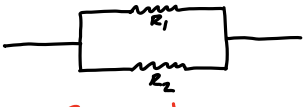
Resistors in Series



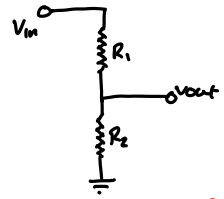
$R_E = R_1 + R_2 + R_N \ldots$

Resistors in Parallel



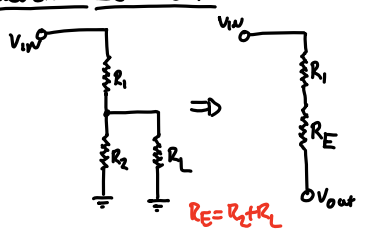
$R_E = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_N}}$

Voltage Divider



$I = \frac{V_{IN}}{R_1 + R_2}$ $V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$

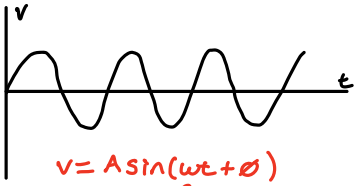
Thevenin Equivalent



$R_E = R_2 + R_L$

$V_{TH} = \frac{R_2}{R_1 + R_2} V_{IN}$ $R_{TH} = \frac{R_1 R_2}{R_1 + R_2}$

Sinusoidal Signal



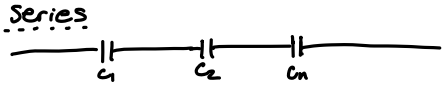
$V = A\sin(\omega t + \phi)$

$\omega = 2\pi f$ ϕ = constant

Capacitors: (series) and (Parallel)

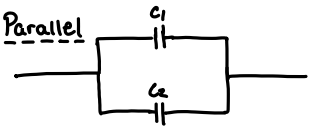
$Q = CV$ $I = C\,dV/dt$

Series



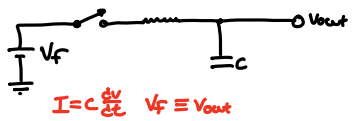
$C_{EQ} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_N}}$

Parallel



$C_{EQ} = C_1 + C_2$

RC Circuits



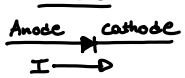
$I = C\frac{dV}{dt}$ $V_f \equiv V_{out}$

$V_{out} = V_f + Ae^{-t/RC}$

$V_{out} = V_f(1 - e^{-t/RC})$

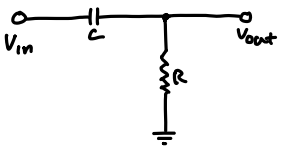
$t = RC\log_e\left(\frac{V_f}{V_f - V_{out}}\right)$

Diodes



Anode +0.6V more than cathode

Differentiator (differentiates Signal)



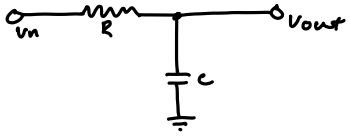
Capacitor First

$I = C\frac{dV}{dt}(V_{in} - V_{out}) = \frac{V_{out}}{R}$

$V_{out}(t) = RC\frac{dv_{in}(t)}{dt}$

$dv_{out}/dt << dv_{in}/dt$

Integrator (Integrates Signal)



Resistor First

$I = C\frac{dV}{dt} = \frac{V_{in} - V_{out}}{R}$

$C\frac{dV}{dt} \cong V_{in}/R$

$V(t) = \frac{1}{RC}\int_t V_{in}(t)dt + C$

Decibels

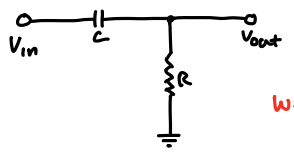
$dB = 10\log_{10} P_2/P_1$

P = Power

$dB = 20\log_{10} A_2/A_1$

A = Amplitude

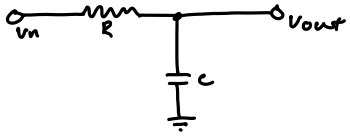
RC Highpass Filter (Blocks low f, passes high f)



$V_{out} = \frac{1}{\sqrt{1 + \omega^2 R^2 C^2}} V_{in}$

$\omega = 2\pi f$ R ≡ Resistance C ≡ Capacitance

RC Lowpass Filter (Blocks high f, Passes low f)



$V_{out} = \frac{\omega RC}{\sqrt{1 + \omega^2 R^2 C^2}} V_{in}$

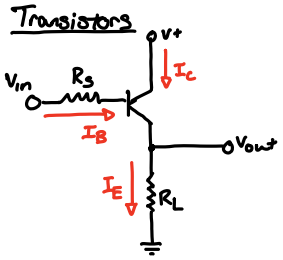
$f_{3dB} = 1/\omega RC$

Input & Output Impedance

$Z_{out} = Z_s/\beta$ $Z_{in} = \beta(Z_L)$

I_E & $I_C = \beta I_B$

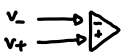
Transistors



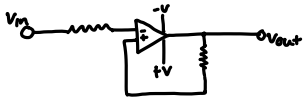
Negative Feedback

GR: • No current through inputs

• V+ & V- are equal



Positive Feedback



GR do not apply

• This is where to calculate trigger points, w/ current loops

• Output will try to go between (V-) & (V+)

Summation Amplifier

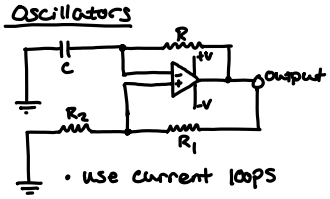
$V_{out} = -V_f\left(\frac{V_A}{R_A} + \frac{V_B}{R_B} \ldots\right)$

Ohms Law

$P = IV = I^2R = V^2/R$

$V = IR$

Oscillators



• use current loops

• Positive side trigger points

• Negative side is RC circuit

Digital Logic

Hex: $0123456789ABCDEF_{16}$

Dec: 0123456789_{10}

Bin: $1010110011000\ldots._2$

Ex:

Hex → Dec:

$2C3_{16} \rightarrow 2\cdot16^2 + 12\cdot16^1 + 3\cdot16^0 = 707_{10}$

Dec → Hex:

$707_{10} \rightarrow$

	Q	R
707/16 =	44	3
44/16 =	2	12
2/16 =	0	2

$= 2C3_{16}$

Ex:

Bin → Dec:

$101_2 \rightarrow 1\cdot2^2 + 0\cdot2^1 + 1\cdot2^0 = 5_{10}$

Dec → Bin:

$5_{10} \rightarrow$

	Q	R
5/2 =	2	1
2/2 =	1	0
1/2 =	0	1

$= 101_2$

Logic Gates

A	Q
0	1
1	0

NOT

A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NAND

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

NOR

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

XOR

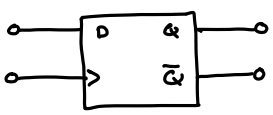
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

OR

D Flip Flop



D	Q	Q̄
0	0	1
1	1	0